JISEA Joint Institute for Strategic Energy Analysis

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Energy-Water Nexus in a Drying West: A Case Study Analysis and Methodology

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Project Description

Researchers analyzed the intersection of energy generation and transmission planning, water demands, climate change, and agricultural water use to determine the water impacts of different energy and climate change scenarios in the South Platte River Basin in Northeastern Colorado. The purpose of this analysis is to better understand 1) the potential climate change impact on water availability, 2) the future water demands of the municipal and the electricity sectors, 3) the ripple effect of fallowing borne by the agriculture economy, and 4) the water savings benefits of energy scenarios that minimize water withdrawals and consumption.

Methodology

1) Changes in Runoff in the South Platte Basin under Climate Scenarios

CU analyzed the work of the Joint Front Range Climate Change Vulnerability Study (JFRVS) and used data to investigate the likely future range of stream flows in the South Platte Basin in 2040. CU also developed 5 scenarios: warm/wet, warm/dry, hot/wet, hot/dry, and a median.

Results

Overall basin flows ranged from reductions of 27% (Hot & Dry) to increases of 27% (Warm & Wet). This equates to annual changes of approximately +/-300,000 acre-feet. Current average basin flows of 1,100,000 acre-feet. These large changes in stream flow have the potential to swamp increased demand for cooling water due to different forms of energy production.

2) Water Demands under Municipal and Energy Scenarios - Municipal Scenarios in 2040

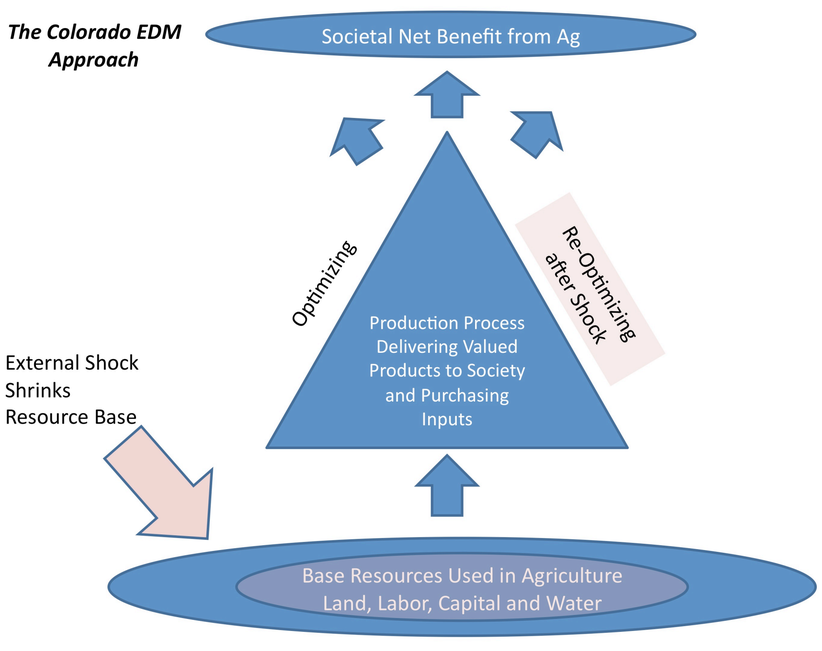
We based the following energy scenarios on the 2010 *Municipal and Industrial Water Conservation Strategies from* CWCB.

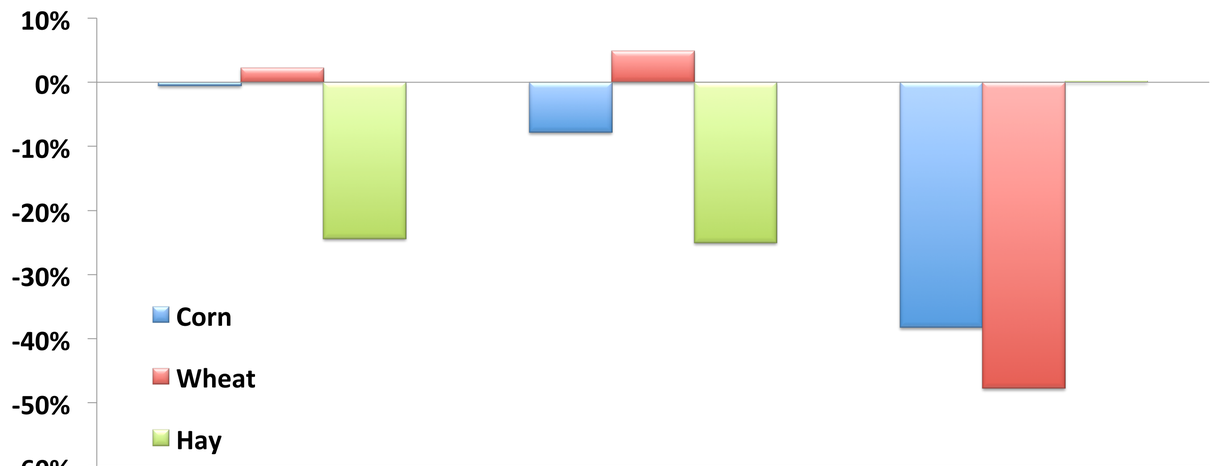
- *High wind scenario* – Wind is exported from the South Platte Basin. It is based on the Local Priority Scenario in the recent West Connect analysis (30% wind and 5% solar in the West)
- *Natural gas scenario* – Forecasts a comparable amount of electricity as the high wind, but at new combined cycle gas plants
- *IGCC & CCS scenario* – Electricity generated with integrated gasification combined cycle (IGCC) coal plants with carbon capture and storage (CCS).

Municipal Scenario	Energy Scenario	Total Change in Water Demands by 2040 (AF)
Baseline	High Wind	285,205
	IGCC & CCS	296,152
	High Gas	289,143
High Conservation	High Wind	64,641
	IGCC & CCS	75,588
	High Gas	68,579

3) Impacts on Agriculture in the Basin

CSU analyzed the agricultural impact of water re-allocation and climate change using the Colorado Equilibrium Displacement Mathematical Programming (CEDMP) model. The equilibrium displacement approach maximizes an objective function of social net benefits by allocating resources such as land, labor, capital and other inputs through market mechanisms and assuming profit maximizing behavior by business owners.





	Simulation 1 (Poor Climate)	Simulation 2 (Forages Benefit)	Simulation 3 (Drought Year)
Corn	-0.6%	-7.8%	-38.2%
Wheat	2.3%	4.9%	-47.7%
Hay	-24.4%	-25.0%	0.2%

Shifting water from the agricultural industry to the energy and municipal sectors will reduce irrigated acres. Likewise, shrinking available water due to climate change will also reduce production of crops.

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